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LISTS OF SPECIES

Insecta, Hymenoptera, Apidae, Serra do Itajaí National Park, state of Santa Catarina, Brazil

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Abstract: A study concerning the bee fauna of the Serra do Itajaí National Park, state of Santa Catarina, was carried out during ten months in the domain of the Atlantic Rainforest. Bees were collected monthly between October 2006 and December 2007, in two sampling localities, from 8:00 h to 16:00 h, totaling 151 h of sampling. Bees were captured with entomological nets in flowers, during flight, on the ground or while foraging for sweat on collectors. A total of 1,616 individuals were collected (1,240 females and 376 males), distributed in 89 species, 46 genera, 16 tribes and five subfamilies. Apinae was the richest subfamily with 47 species. The genera with the greatest number of species were *Augochloropsis* Cockerell, 1897 (nine), *Ceratina* Latreille, 1802 (nine) and *Dialictus* Robertson, 1902 (seven). *Paratetrapedia fervida* (Smith, 1879) was the most abundant species, comprising 11.57 % of the sampled individuals.

Introduction

Bees are among the main pollinating agents of Angiosperms (Roubik 1989). It is estimated that there are more than 4,000 genera and nearly 20,000 bee species inhabiting different regions of the world (Michener 2007) and approximately 85 % of these species are solitary (Batra 1984). In Brazil, Silveira *et al.* (2002) listed 1,573 valid species names, although they suggested that Brazilian bee fauna is composed by 3,000 bee species.

In order to advance in the knowledge about Brazilian bee fauna, new studies on the composition and distribution of these species are necessary (Silveira and Godínez 1996). Systematic surveys concerning bee communities in Brazil started with the work of Sakagami *et al.* (1967), which was carried out in an area of secondary grassland in the municipality of São José dos Pinhais, Paraná.

In the state of Santa Catarina, there is a huge lack of information about the fauna of bees, whereas only three systematized inventories regarding bee fauna have been performed up to date (Ortolan and Laroca, 1996; Steiner *et al.* 2006; Krug and Alves-dos-Santos 2008). Thus, the objective of this work was to contribute to the knowledge of the bee diversity in an area with a predominance of dense ombrophilous forest in the Serra do Itajaí National Park, state of Santa Catarina, Brazil.

Materials and Methods

Study Site

The Serra do Itajaí National Park (SINP) (Figure 1) is situated entirely within the Itajaí Valley, in the northeastern portion of the state of Santa Catarina. The park includes parts of nine municipalities (Blumenau, Indaial, Botuverá, Gaspar, Vidal Ramos, Apiúna, Guabiruba, Ascurra and Presidente Nereu) and has an area of 57,374 ha. SINP presents a very restricted topography where the altitudes vary between 80 and 1,039 meters above sea level. According to the Köppen classification, climate is of the Cfa type, with average temperature between 7.5 °C and 13 °C in the coldest month, hot summers, and average temperature between 28 °C and 31 °C in the hottest month (Gaplan 1986). The annual precipitation varies between 1.600 and 1.800 mm, with 120 to 140 rainy days throughout the year; relative humidity ranges from 75 to 80 % (Klein 1979). The forest formation is represented by submontane and montane dense ombrophilous forest (Klein 1984).

Samplings were carried out in two distinct localities of the park: "Rancho do Mono", located in the municipality of Indaial (27°03'00" S, 49°08'57" W; 700 m altitude) and "Terceira Vargem", located in the municipality of Blumenau (27°03'37" S, 49°06'43" W; 390 m altitude). Cure *et al.* (1991) suggest that collecting bees in two different

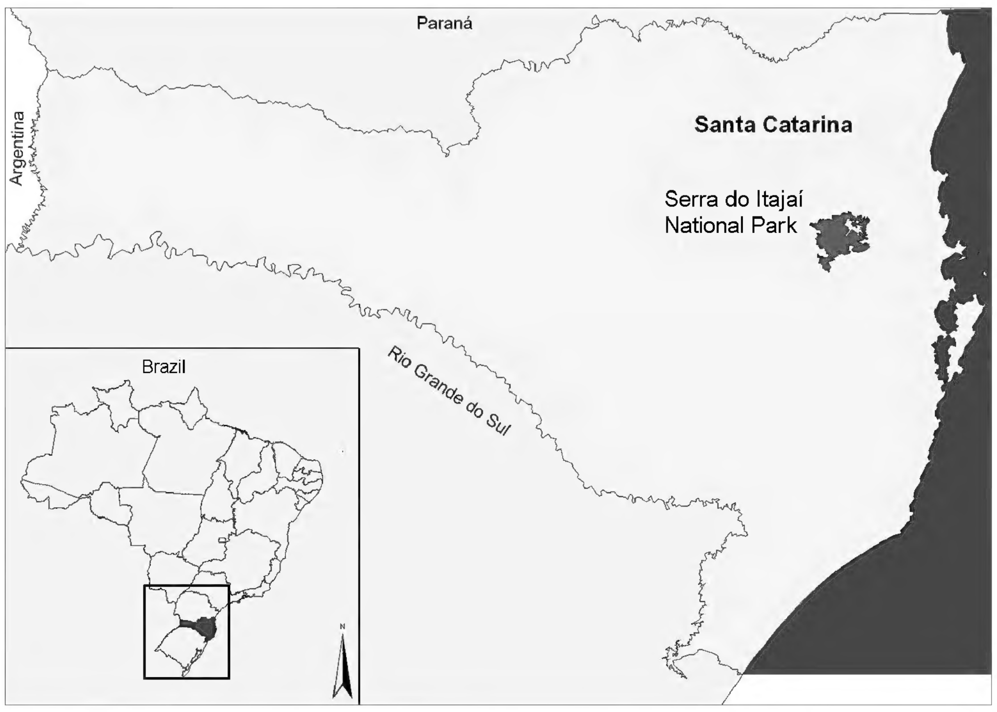

Figure 1. Map showing location of Serra do Itajaí National Park, state of Santa Catarina, south Brazil.

points is more appropriate to estimate the relative species richness of a region. These areas are separated by nearly four kilometers, and both of them are about three kilometers distant from an area with pristine vegetation of more than 600 ha.

Data Collection

Samplings were performed on a monthly basis from October 2006 to December 2007, during two consecutive days for each area in the period from 8:00 h to 16:00 h, comprising 10 samplings (five in each study site). The collection scheduled for November 2006 was prematurely interrupted by a prolonged rain. Due to the low temperatures registered between the months of May and August, with consequent reduction of flowering plants and bee activity, these months were not sampled in 2007. The option of not performing collections during the cold months followed the work of Cure *et al.* (1991). These authors state that reliable estimates of relative bee richness can be performed from partial samplings involving only the months of greater activities of these insects.

Equipped with entomological nets and killing jars, two collectors covered a 1,000-meter transect established alongside a road that cuts the study area to capture bees. Flowering plants were observed between thirty seconds and five minutes in the case of intense bee foraging. Bees were also captured in other situations: during flight, on the ground or foraging for sweat on collectors. Bee sampling was limited to the borders of the fragments, since access to the interior of the forest was virtually impossible in most cases. The captured individuals were killed with ethyl acetate and mounted on entomological pins. *Apis mellifera* Linnaeus, 1758 individuals were quantified in field through capture and later discarded.

After preparation and separation of morph-species, the bees were sent to specialists for identification. The collected specimens were deposited in the Zoological Collection of the Universidade Regional de Blumenau (CZFURB-IN) and in the Entomological Collection "Pe. J. S. Moure" (DZUP) of the Zoology Department, Universidade Federal do Paraná (UFPR). The meteorological data concerning average daily temperature were obtained at the Centro de Informações de Recursos Ambientais e de Hidrometeorologia de Santa Catarina (EPAGRI-CIRAM), referent to the Indaial station located close to the park.

Results and Discussion

The bee community was represented by 89 morph-species, with the identification of 60 species, 46 genera, 16 tribes and five subfamilies, with 1,616 collected individuals (Table 1). Of this total, 376 were males, in the approximate proportion of 3.3 females per male (or 2.9 females per male when the *A. mellifera* workers are excluded). Among the sampled species, 6.7 % present a cleptoparasitic life cycle (Table 1).

The number of cleptoparasitic species found in this study was similar to those found by Krug and Alves-dos-Santos (2008), where they represented 6.1 % of all collected species. According to Heithaus (1979), the frequency of these species in the bee communities seems to be constant and independent of latitude. The author suggests that an average of 11 % of the species present in the community are cleptoparasites, even though other works present smaller numbers (such as this study) or higher numbers, such as the work of Steiner *et al.* (2006), where cleptoparasite species represent 16.3 % of the community.

Apinae was the most species-rich subfamily (47; 52.81 %), followed by Halictinae (30; 33.71 %), Megachilinae (5; 5.62 %), Colletinae (4; 4.49 %) and Andreninae (3; 3.37 %). With nine species each, *Augochloropsis* and *Ceratina* were the most species-rich genera, followed by *Dialictus* (seven species) and *Plebeia* Schwarz, 1938 (four species).

Apinae was also the most abundant subfamily (81.62 %), followed by Halictinae (12.32 %), Andreninae (3.71 %), Megachilinae (2.04 %) and Colletinae (0.31 %). The great abundance of Apinae is mainly due to eusocial species such as *A. mellifera*, *Bombus brasiliensis* Lepeletier, 1836, *Plebeia droryana* (Friese, 1900) and *Trigona spinipes* (Fabricius, 1793) solitary species such as *Paratetrapedia fervida* (Smith) and *Trigonopedia ferruginea* (Friese, 1899) and the genera *Ceratina*, which presented two very abundant species (Table 1). The most abundant species was *P. fervida*, corresponding to 11.57 % of the total collected individuals.

In the present study, the species with eusocial behavior represented 37.75 % of the collected individuals, and it is noteworthy that only four species represented 27.6 % of the total collected individuals: *A. mellifera*, *B. brasiliensis*, *P. droryana* and *T. spinipes*. According to Jarau *et al.* (2003), the large abundance of these species is related to their capacity of communicating the location of food resources to other workers of the colony, causing the appearance of a high number of bees from a single colony in flowers (Roubik, 1989).

The most abundant species of the present study was *P. fervida* (Tapinotaspidini). This large abundance is mainly due to the intensive flowering of *Cuphea origanifolia* Cham. & Schltdl, 1827 in November and December 2007 in the Terceira Vargem area. It is important to note that the intensive flowering of this plant was present along approximately 100 m of the transect and that the collectors passed by it many times a day. During this period, 123 *P. fervida* individuals representing 65.77 % of all collected individuals were captured on these flowers.

Species from the Tapinotaspidini tribe present preferences for nesting habitats and frequently choose sites closer to flower resources, possibly forming large aggregations (Michener 2007). This may explain the large quantity of individuals from this tribe captured in a single plant species, since it was established in a single point of the study area.

It is probable that the high abundance of *P. fervida* is an artifact caused by the waiting time of up to five minutes in the *C. origanifolia* flowers. Aware of this problem, Sakagami *et al.* (1967) suggest that when there is massive flowering of a plant in a determined area attracting a large number of bees, the largest number of specimens should be captured at once, moving to other sites along the transect without waiting for the arrival of new individuals.

A significant decrease in the number of collected species and individuals occurred in April (Table 2). This

was possibly caused by the abrupt reduction of flowering plants in the sampled area due to lower temperatures and the rainless period that started in March that occurred in this region. According to Aguiar and Martins (1997), rain directly influences the flowering patterns of plants and, consequently, the availability of food resources for bees.

In general, the activity period of the bees from the Serra do Itajaí National Park during the day was very broad (Figure 2). The highest number of individuals were sampled between 12:00 h and 14:00 h, as well as the highest number of species (n = 59). The period with the least bee activity occurred between 8:00 h and 10:00 h, same period when the lowest number of species was collected.

We believe that the time of waiting in the flowers, until five minutes, has been excessive, which may have over-sampled certain groups. Moreover, most of the bees were collected in the first minutes and the presence of collectors close of plants might have inhibited the approximation of certain bees.

Despite the methodological limitations, collection with entomological net presents the best results regarding relative bee abundance within a community (Sakagami *et al.* 1967). Finally, this list of species provides an important advance in the knowledge of the bee fauna in the state of Santa Catarina.

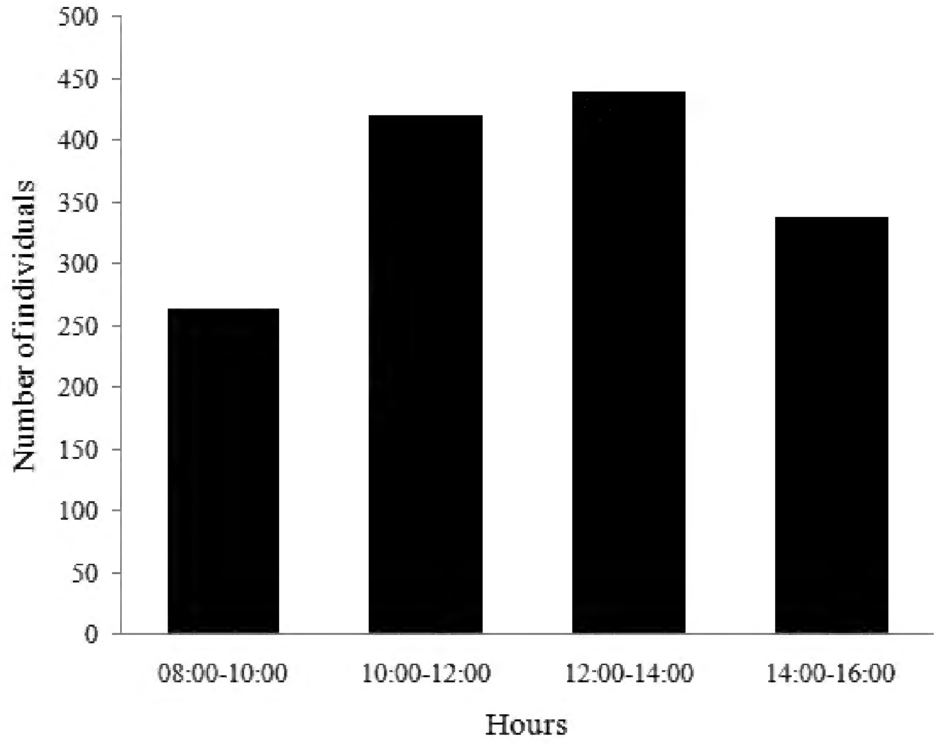

Figure 2. Time of activity of the bees collected in the Serra do Itajaí National Park between October 2006 and December 2007, with the exception of November 2006 and May to August 2007. Not counting the *Apis mellifera* individuals.

Table 1. Bees collected in the Serra do Itajaí National Park, SC, from October 2006 to December 2007, with the exception of November 2006 and May to August 2007. M = males, F = females, ON = on flowers. An asterisk (*) indicates cleptoparasitic species.

Subfamily/Tribe/Species	Number of Individuals			
	M	F	OF	Total
ANDRENINAE				
Protandrenini				
Anthrenoides cyphomandrae Urban, 2005	3	2	5	5
Anthrenoides meridionalis (Schrottky, 1906)	11	40	51	51
Psaenythia sp.	1	3	4	4
APINAE				
Apini				
Apis mellifera Linnaeus, 1798	-	153	140	153
Bombus (F.) brasiliensis Lepeletier, 1836	1	70	63	71
Bombus (F.) morio (Swederus, 1787)	-	17	12	17
Lestrimelitta sulina Marchi & Melo, 2006	-	1	-	1
Melipona bicolor Lepeletier, 1836	-	23	12	23
Melipona marginata Lepeletier, 1836	-	19	8	19
Melipona mondury Smith, 1863	-	1	-	1
Paratrigona subnuda Moure, 1947	-	3	3	3
Partamona helleri (Friese, 1900)	-	27	2	27
Plebeia droryana (Friese, 1900)	-	138	138	138
Plebeia emerina (Friese, 1900)	-	11	11	11
Plebeia remota (Holmberg, 1903)	-	16	16	16
Plebeia saiqui (Friese, 1900)	-	17	15	17
Scaptotrigona bipunctata (Lepeletier, 1836)	-	2	2	2
Scaptotrigona tubiba (Smith, 1863)	-	3	3	3
Schwarziana quadripunctata (Lepeletier, 1836)	-	4	4	4
Tetragonisca angustula (Latreille, 1811)	-	19	19	19
Trigona spinipes (Fabricius, 1793)	-	85	84	85

Table 1. *Continued.*

Subfamily/Tribe/Species	Number of Individuals			
	M	F	OF	Total
Centridini				
Centris (Melacentris) sp.	-	1	1	1
Eucerini				
Dithygater seabrai Moure & Michener, 1955	2	-	2	2
Florilegus (F.) condignus (Cresson, 1878)	-	1	1	1
Melissoptila setigera Urban, 1998	1	-	1	1
Thygater analis (Lepeletier, 1841)	-	2	2	2
Trichocerapis mirabilis (Smith, 1865)	-	3	3	3
Nomadini				
Brachynomada sp. *	-	2	2	2
Osirini				
Osiris sp.1 *	1	1	2	2
Osiris sp.2 *	1	-	1	1
Protosiris mcginleyi (Shanks, 1986) *	4	1	5	5
Tapinotaspidini				
Monoeca haemorrhoidalis (Smith, 1854)	8	12	1	20
Paratetrapedia fervida (Smith, 1859)	139	48	178	187
Paratetrapedia volatilis (Smith, 1879)	31	30	56	61
Trigonopedia ferruginea (Friese, 1899)	114	29	142	143
Trigonopedia nigrifascies Harter-Marques & Truylio, 2003	1	26	27	27
Trigonopedia sp.	2	1	2	3
Tetrapediini				
Tetrapedia diversipes Klug, 1810	-	1	1	1
Xylocopini				
Ceratina (Ceratinula) sp.1	-	72	70	72
Ceratina (Ceratinula) sp.2	-	1	1	1
Ceratina (Ceratinula) sp.3	-	27	27	27
Ceratina (Crewella) sp.1	-	19	18	19
Ceratina (Crewella) sp.2	1	4	5	5
Ceratina (Crewella) sp.3	-	4	4	4
Ceratina (Crewella) sp.4	-	1	1	1
Ceratina (Crewella) sp.5	13	77	90	90
Ceratina (Rhisoceratina) sp.	-	2	2	2
Xylocopa (N.) brasilianorum (Linnaeus, 1767)	2	15	13	17
Xylocopa (N.) frontalis (Olivier, 1789)	-	2	1	2
Xylocopa (S.) artifex Smith, 1874	-	7	6	7
Colletini				
Colletes petropolitanus Dalla Torre, 1896	-	2	2	2
Diphaglossini				
Mydrossoma aterrimum (Friese, 1925)	-	1	-	1
Zikanapis seabrai Moure, 1953	1	-	-	1
Xeromelissini				
Chilicola (H.) cf. megalostigma (Ducke, 1908)	-	1	1	1

Table 1. *Continued.*

Subfamily/Tribe/Species	Number of Individuals			
	M	F	OF	Total
HALICTINAE				
Augochlorini				
Ariphanarthra palpalis Moure, 1951	-	13	12	13
Augochlora amphitrite (Schrottky, 1910)	19	46	64	65
Augochlora cf. cydippe (Schrottky, 1910)	-	1	1	1
Augochlora sp.	-	1	1	1
Augochlorella urania (Smith, 1853)	-	11	9	11
Augochloropsis cleopatra (Schrottky, 1902)	1	5	6	6
Augochloropsis cognata Moure, 1944	-	4	3	4
Augochloropsis discors (Vachal, 1903)	-	13	11	13
Augochloropsis imperialis (Vachal, 1903)	-	2	2	2
Augochloropsis nasuta Moure, 1944	-	12	9	12
Augochloropsis patens (Vachal, 1903)	-	2	2	2
Augochloropsis sp.1	-	10	8	10
Augochloropsis sp.2	-	1	1	1
Augochloropsis sp.3	1	1	2	2
Ceratalictus sp.	-	1	1	1
Neocorynura oiospermi (Schrottky, 1909)	-	5	5	5
Neocorynura sp.	-	2	2	2
Paroxystoglossa transversa Moure, 1943	-	7	2	7
Paroxystoglossa sp.	-	5	2	5
Pseudaugochlora graminea (Fabricius, 1804)	-	1	1	1
Rhectomia mourei (Eickwort, 1969)	-	4	3	4
Temnosoma sp. *	-	1	1	1
Halictini				
Caenohalictus sp.	-	1	1	1
Dialictus anisitsianus (Strand, 1910)	-	2	2	2
Dialictus travassosi (Moure, 1940)	-	1	1	1
Dialictus sp.1	4	12	11	16
Dialictus sp.2	-	1	1	1
Dialictus sp.3	1	2	2	3
Dialictus sp.4	-	1	1	1
Dialictus sp.5	1	4	4	5
MEGACHILINAE				
Anthidiini				
Hyphantidium divaricatum (Smith, 1854)	10	12	21	22
Megachilini				
Coelioxys (R.) zapoteca Cressom, 1878 *	-	1	1	1
Megachile (A.) susurrans Haliday, 1836	-	3	3	3
Megachile (C.) pseudanthidioides Smith, 1854	2	2	2	4
Megachile (M.) maculata Smith, 1853	-	3	3	3
Total	**376**	**1240**	**1461**	**1616**

Table 2. Collection data from October 2006 to December 2007, with the exception of November 2006 and May to August 2007, in the Serra do Itajaí National Park. Area (M = Mono, TV = Terceira Vargem), total number of collection hours per collector, abundance = number of individuals, percentage of *Apis mellifera* individuals, Spp. = number of species, AT = average temperature (in °C).

Date	Area	Hours	Abundance	% *Apis*	Spp	AT
October/2006	M	15:40	129 (8.0 %)	55.81	25	19.8
December/2006	M	16:10	107 (6.6 %)	8.41	27	27.4
January/2007	TV	16:20	177 (10.9 %)	1.13	24	24.4
February/2007	M	15:30	147 (9.1 %)	0	32	26.3
March/2007	TV	15:56	245 (15.2 %)	0.82	26	27.6
April/2007	M	13:47	33 (2.0 %)	27.27	12	24.4
September/2007	M	14:40	160 (9.9 %)	31.25	15	19.3
October/2007	TV	13:15	103 (6.4 %)	0	29	27
November/2007	TV	14:35	215 (13.3 %)	0.93	22	20.1
December/2007	TV	15:03	300 (18.6 %)	2.33	31	25.3
Total		06:56	1616	9.47 %		

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